



Protein-Controlled Diets With or Without Sodium and Potassium Restriction

General Description

Dietary protein provides both essential and nonessential amino acids for the synthesis of visceral and somatic proteins. In the adult population, the eight essential amino acids (isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine) must be obtained from food sources and cannot be synthesized by the human body. Nonessential amino acids can be synthesized via the human body. Protein requirement is fundamentally a requirement for essential amino acids.

The goals of diet therapy when renal or liver function is impaired are to achieve and/or maintain optimal nutritional status and to alleviate the workload of the diseased organ by reducing metabolic by products such as urea, uric acid, ammonia, creatinine or electrolytes (especially sodium and potassium)^{1,2,3}. Achievement of these goals requires regulation of protein intake, adequate calorie intake and may include modification of sodium, potassium and fluid as well as supplementation with appropriate vitamins and minerals (Table 1).

Protein requirements are based on sex, age, rate of growth, degree of physiologic stress, and metabolic factors. The RDA for protein for adults is 0.8 grams per kilogram of body weight per day⁴. The level of protein intake in the diet is determined by the degree of renal or liver impairment and the patient's clinical symptoms.

RENAL

Much controversy exists over the specific amounts of protein recommended for individuals with progressing renal disease. Protein restriction is usually advised only when the patient has a creatinine clearance of less than 30-40 ml/min/1.73 sq. meter as indicated below⁵.

Despite some limitations, creatinine clearance is generally considered to be good estimation for glomerular filtration rate⁶.

Recommended Protein Intake According to Degree of Chronic Renal Failure

Creatinine Clearance	Protein Intake (grams/day)
30-40	60
20-30	50
15-20	40
10-15	30
5-10	15-25

Intakes of less than 40 grams of protein for adults per day may require supplementation with essential amino acids^{5,7}. Future guidelines will likely change as more information becomes available from ongoing studies such as The Modification of Diet in Renal Disease⁸.

Hyperphosphatasemia may also be a problem in renal failure. Dietary phosphorous can be reduced to 600-900 mg per day by decreasing the protein intake, particularly by limiting meat and milk products⁹. Dietary restriction alone may not be sufficient to correct the hyperphosphatasemia. The addition of a phosphate binder is frequently required.

Protein-Controlled Diets

The normal BUN to serum creatinine ration is about 10:1. Changes in the BUN/serum creatinine ratio may also be used as an indications of protein status. A high protein diet can be a possible cause of a high BUN to creatinine ratio impressions with compromised renal function. Creatinine production can be subnormal in patients with reduced muscle mass also resulting in a high BUN/Cr ratio⁶. A low BUN/Cr ratio may signal increased degradation of somatic protein and should prompt the evaluation of the adequacy of intake of calories and protein.

Table 1: Dietary Modification for Renal Disease or Treatment

Nutrient	Acute Renal Failure	Chronic Renal Failure (GFR: 4-10 ml/min)	Hemodialysis (GFR: <5 ml/min)	Peritoneal Dialysis (GFR: <5 ml/min)	Post Kidney Transplant (GFR: 125 ml/min)
Protein (g/kg)	0.5*	0.55-0.60*	1.0-1.2*	1.2-1.5*	0.8-2.0
Calories (kcal/kg)	Dependent upon degree of catabolism	35-45	35	25	To meet requirements to maintain or achieve ideal body weight
Na+ mEq/mg	Dependent upon severity of renal damage	87.0-175.0/2000-4000; dependent upon sodium retention or losses	20.0-130.0/500-3000; dependent upon degree of hypertension and losses	87.0-130.0/2000-3000	92.0/2000
K+ mEq/mg	Dependent upon severity of renal damage	Usually not restricted	50.0-80.0/2000-3000	75.0-90.0/3000-3500	No restriction
Fluid	Balance intake and output	Balance intake and output	Daily urine output plus 500-800 cc	Daily urine output plus 500-800 cc	No restriction
Vitamins	Daily supplementation of water soluble vitamins and folic acid	Daily supplementation of water soluble vitamins	Daily supplementation of water soluble vitamins and folic acid	Daily supplementation of water soluble vitamins and folic acid	Dietary intake should meet RDA; supplement as necessary
Minerals†	Minimum supplementation to meet RDA for Fe++ and Ca++	Minimum supplementation to meet RDA for Fe++ and Ca++	Minimum supplementation to meet RDA for Fe++ and Ca++	Minimum supplementation to meet RDA for Fe++ and Ca++	Dietary intake should meet RDA; supplement as necessary

* 50-75% of protein should be of high biologic value.

† Phosphorus intake may be restricted to control serum levels. Phosphate binders also may be prescribed.

Reprinted with permission from Massachusetts General Hospital Department of Dietetics, Diet Reference Manual, 2nd Edition, 1984.

Protein-Controlled Diets

Nephrotic Syndrome

Nephrotic syndrome is manifested by albuminuria, hypoalbuminemia, edema, hypercholesterolemia and may be treated with a diet high in protein of good biologic value (usually the RDA for protein plus urinary losses of protein). The diet should be moderately low in sodium (2-4 grams/day) depending on patient acceptance and degree of edema. Although the degree of risk of atherosclerosis due to hyperlipidemia for the nephrotic patient is a matter of controversy, a diet low in saturated fat may be advisable¹⁰. Fluid intake may need to be restricted if hyponatremia is present. Potassium usually does not need to be restricted^{5, 10}. Vitamin and mineral supplementation recommendations are similar to those in Table 1.

Liver Disease

A protein restricted diet may be beneficial to patients with hepatic encephalopathy characterized by episodes of mental confusion, lapses of sustained muscle contractions (asterixis), progressive drowsiness and coma. Dietary protein may be restricted to levels as low as 20 grams per day for adults⁹.

Because malnutrition is often a common finding in patients with liver disease, the benefits of a low protein diet need to be weighed against the risk of further nutritional depletion. For this reason low protein diets should only be used in the management of acute symptoms in conjunction with medications to decrease the gastrointestinal production and absorption of nitrogen.

The abnormally high ration of aromatic amino acids (AAAs) to branch-chain amino acids (BCAAs) has been proposed a possible cause of hepatic encephalopathy. It has been shown that administration of formulas enriched in BCAA and depleted in AAAs can normalize plasma ratios. However, an improvement in the degree of encephalopathy by this normalization of the AAA-BCAA ration has not been regularly observed⁹.

Indications for Use

These diets may be used in the treatment of impaired renal or liver function. Additionally, low protein diets are used at the Clinical Center in conjunction with drug therapy for various diseases including Parkinson's Disease and cancer.

Nutritional Adequacy

In comparison to the Recommended Dietary Allowances, the 20 and 40 gram protein diets may be inadequate in protein, calcium, iron, zinc, folic acid, vitamin B12 and the B complex vitamins^{4,12}. The 60 gram protein diet is adequate in all nutrients with the same exceptions as for the regular diet.

General Considerations

- Adequate caloric intake (35-45 kcal/kg/day) is necessary to prevent tissue protein catabolism. This can be achieved through the increased use of carbohydrates and appropriate types of fat. Modular components and supplemental products are also available to further boost overall calories.
- Consider the patient's disease state and individual needs to determine if sodium and potassium restrictions are required.
- A diet less than .6 gm protein/kg of body weight should consist of 50 to 75% high biologic value protein to provide the required essential amino acids. Sources of high biological value protein include egg, meat, fish, poultry, and dairy products¹⁰.

Protein-Controlled Diets

Guidelines

Protein-Controlled Renal Diets (20gm, 40gm, or 60gm) Sodium and Potassium Restricted¹⁰

Food Groups	Servings/Day	Foods Allowed	Foods Not Allowed
Dairy	1 cup	<p>1 cup milk equals 8 gm protein, 9 mEq potassium</p> <p>Skim, low-fat or whole milk; buttermilk, unsalted; evaporated milk, reconstituted; low-sodium milk; nonfat dry milk, reconstituted.</p>	Chocolate milk, condensed milk, ice cream, malted milk, milkshake, milk mixes, sherbet.
Meat or Substitute	1 oz.	<p>1 oz. cooked equals 7 g protein, 2.5 mEq potassium</p> <p>Beef, chicken, duck, lamb, liver, pork, turkey, veal.</p> <p>Unsalted fish and shellfish (all shellfish omitted on sodium restricted diet).</p> <p>Egg (1 egg equals 7 g protein, 2 mEq potassium)</p> <p>Cheese (1 oz equals 7 g protein, 1 mEq potassium)</p> <p>cheddar, cottage, American, swiss (use salt-free cheese on sodium restricted diets).</p>	<p>Brains, kidneys. Canned, salted, or smoked meats: bacon, bologna, chipped beef, corned beef, frankfurters, ham, kosher meats, luncheon meats, salt pork, sausage, smoked tongue.</p> <p>Frozen fish fillets. Canned, salted, or smoked fish: anchovies, cod (dried and salted, herring, halibut, sardines, salmon, tuna, flounder, sole; peanut butter.</p>

Protein-Controlled Diets

Vegetables Group 1	As Allowed.	<p>1 g protein, 2 mEq potassium per serving</p> <p>1/2 cup servings of raw cabbage, cucumber, lettuce, onion, tomato.</p> <p>1 g protein, 3 mEq potassium per serving</p> <p>1/2 cup servings of canned green or wax beans, carrots (+), spinach (+); fresh cooked cabbage, eggplant, mustard greens, onion, summer squash.</p> <p>THE FOLLOWING MAY BE USED FOR DIETS WITH LIBERAL POTASSIUM ALLOWANCES:</p> <p>1 g protein, 5 mEq potassium per serving</p> <p>1/2 cup servings of canned beets (+), rutabagas, tomatoes (+); fresh cooked carrots (+), turnips (+); frozen summer squash, winter squash.</p>	<p>All items marked (+) may not be allowed if diet is sodium restricted.</p> <p>Artichokes, baked beans, dried beans, lima beans, beet greens, fresh broccoli, brussel sprouts, raw carrot, raw celery, raw chard, raw endive, parsnips, peas, potato (in skin or frozen), sauerkraut, spinach (fresh or frozen), baked squash.</p>
Vegetables Group 2	As Allowed.	<p>2 g protein, 4 mEq potassium per serving</p> <p>1/2 cup servings of canned asparagus; fresh or frozen green or waxed beans, okra.</p> <p>THE FOLLOWING MAY BE USED FOR DIETS WITH LIBERAL POTASSIUM ALLOWANCE:</p> <p>2 g protein, 6 mEq potassium per serving</p> <p>1/2 cup servings of fresh or frozen cauliflower; cooked dandelion greens (+); potato, boiled (pared before cooking) or mashed.</p>	

(+) Indicates foods high in sodium.

Protein-Controlled Diets

Vegetables Group 3	As Allowed.	<p>3 g protein, 5 mEq potassium per serving</p> <p>1/2 cup serving of kale (+); frozen asparagus, broccoli, collards (+), mixed vegetables (+), whole kernel corn.</p>	
Fruit & Fruit Juices Group 1	As Allowed.	<p>Less than 0.5 g protein, 2 mEq potassium per serving</p> <p>Apple raw (1 small), grapes (12), 1/2 cup servings of canned applesauce, pears, pineapple; watermelon (diced).</p> <p>1/2 cup of juice: apple, grape, peach nectar, pear nectar, cranberry.</p> <p>THE FOLLOWING MAY BE USED FOR DIETS WITH LIBERAL POTASSIUM ALLOWANCE:</p> <p>Less than 0.5 g protein, 4 mEq potassium per serving</p> <p>1/2 cup serving of apricot nectar, pineapple juice, canned fruit cocktail, peaches, purple plums.</p>	All dried and frozen fruits with sodium sulfite added. Fresh apricots, avocado, bananas, glazed fruits, maraschino cherries, nectarine, prunes, raisins.
Fruits & Fruit Juices Group 2		<p>1 g protein, 4 mEq potassium per serving</p> <p>Pear (1 medium), tangerine (1 small).</p> <p>1/2 cup serving of fresh or frozen blackberries, blueberries, canned cherries, canned or fresh grapefruit, frozen red raspberries.</p>	Tomato juice if diet is sodium restricted.

(+) Indicates foods high in sodium.

Protein-Controlled Diets

Fruits & Fruit Juices

Group 2
(continued)

**THE FOLLOWING MAY
BE USED FOR DIETS
WITH LIBERAL POTAS-
SIUM ALLOWANCE:**

**1 g protein, 5 mEq
potassium per serving**

Orange (1 small);
peach (1 small); plums
(2 medium); strawber-
ries (2/3 cup). 1/2 cup
servings of cantaloupe,
figs, honeydew, frozen
melon balls.

1/2 cup of juice:
orange, tomato, grape-
fruit (salt-free tomato
juice can be used if
diet sodium restricted).

Bread & Starch
Low protein bread/pasta

As Allowed.

**.5g protein, .5 mEq
potassium per serving**

Bread, low protein
(1 slice). Pasta, low
protein (1 cup).

*Regular bread
and starch*

As Allowed.

**3 g protein, 1 mEq
potassium per serving**

Bread (1 slice). Cereals,
dry (1 cup): cornflakes,
corn pops, Rice Krispies,
puffed rice, puffed wheat,
shredded wheat. Cereals,
cooked (1/2 cup): corn-
meal, farina, rice, rolled
wheat. Soda crackers (3
squares). Flour (2 tbsp.);
Grits (1 cup). Macaroni,
noodles, or spaghetti
(1/4 cup). Rice (1/2 cup).

Yeast breads, rolls or
melba toast made with
salt or from commercial
mixes. Quick breads
made with baking
powder, baking soda,
or salt, or made from
commercial mixes.
Commercial baked
products. Oatmeal. Dry
cereals except as listed.
Self-rising cornmeal.
Graham or other crack-
ers except low sodium
dietetic. Self-rising flour.
Salted popcorn, potato
chips, pretzels; waffles
containing salt, baking
powder, baking soda,
or egg white.

(+) Indicates foods high in sodium.

Protein-Controlled Diets

Fats	As Desired.	<i>Negligible protein and potassium</i> Butter, light or heavy cream (1 oz. contains 35 mg potassium), fat or cooking oil, margarine, salad dressings not containing cream or cheese (+).	Avocado, bacon, bacon fat, olives, nuts, salt pork. Salad dressings containing cream or cheese.
Beverages		Lemonade, koolaid, most carbonated beverages. Tea, coffee, decaffeinated coffee (limit on potassium-restricted diet).	Cocoa, instant cocoa mixes, fruit-flavored powders, and prepared beverages. Electrolyte replacement beverages.
Soups	1	Cream soups may be substituted for 1 serving of milk.	Bouillon, broth; canned, dried, or frozen soups; consomme.
Desserts	1-2	Fruit ice, flavored gelatin, popsicle, cookies, and cake (as allowed).	Custard, puddings, fruit pies, baked fruit desserts, ice cream, sherbet.
Miscellaneous		Cornstarch, flavoring extracts, hard candies, herbs, honey, jam or jelly, jelly beans, sour balls, spices, white or confectioners sugar, syrup, granulated tapioca, vinegar, rice starch, wheat starch, lemon.	Chocolate, coconut. Commercial candies except as listed. Regular baking powder and soda. Rennin tablets. Molasses, catsup, celery leaves, celery salt, chili sauce, garlic salt, prepared horseradish, meat extracts, meat sauces, meat tenderizers, monosodium glutamate, prepared mustard, onion salt, pickles, relishes, salt and salt substitutes, soy sauce, worcestershire sauce.

(+) Indicates foods high in sodium.

Protein-Controlled Diets**Suggested Meal Plan*****20gm Protein, 29 mEq K+*****Breakfast**

240cc Apple Juice
and 30cc Polycose

1 Egg
or Substitute

2 Slices
Low-Protein Bread

4 Margarine

4 Jelly

2 Non-Dairy Creamers

Beverage

Sourballs

Lunch

1 Serving Vegetable
(Group 1)

2 Servings Fruit
(Group 1)

2 Slices Low-Protein Bread
or 1 Cup Low-Protein Pasta

4 Margarine

240cc Lemonade
and 30cc Polycose

Dinner

1 Serving Vegetable
(Group 2)

2 Servings Fruit
(Group 1)

2 Slices Low-Protein Bread
or 1 Cup Low-Protein Pasta

4 Margarine

240cc Lemonade
and 30cc Polycose

120cc Milk

40gm Protein, 36 mEq K+**Breakfast**

240cc Apple Juice
and 30cc Polycose

1 Serving Hot Cereal

1 Egg
or Substitute

1 Slice Low-Protein Bread

4 Margarine

4 Jelly

2 Non-Dairy Creamers

Beverage

Lunch

1 Serving Vegetable
(Group 1)

2 Servings Fruit (Group 1)

2 Slices Low-Protein Bread
or 1 Cup Low-Protein Pasta

4 Margarine

240cc Lemonade
and 30cc Polycose

120cc Milk

Dinner

60gm Meat
or Substitute

1 Serving Vegetable (Group 2)

2 Servings Fruit
(Group 1)

1 Serving Bread or Starch

2 Slices Low-Protein Bread
or 1 Cup Low-Protein Pasta

4 Margarine

240cc Lemonade
and 30cc Polycose

Protein-Controlled Diets

Suggested Meal Pattern

Food Groups	20gm Protein (29 mEq K+)	40gm Protein (36 mEq K+)	60gm Protein (38 mEq K+)
<i>Dairy</i>			
(9 mEq K+/serv)	1/2 Serving	1/2 Serving	1/2 Serving
<i>Meat/Fish/Poultry/Egg/Cheese</i>			
(1-2.5 mEq K+ serv)	1 Ounces	3 Ounces	5 Ounces
<i>Vegetables</i>			
<i>Group 1</i> (2-3 mEq K+/serv)	1 Serving	1 Serving	1 Serving
<i>Group 2</i> (4 mEq K+/serv)	1 Serving	1 Serving	2 Servings
<i>Group 3</i> (5 mEq K+/serv)	—	—	—
<i>Fruit/Fruit Juice</i>			
<i>Group 1</i> (2 mEq K+/serv)	6 Servings	6 Servings	6 Servings
<i>Group 2</i> (4 mEq K + /serv)	—	—	—
<i>Bread & Starch—Salted</i>			
(1 mEq K+/serv)	0	2 Servings	4 Servings
<i>Fats—Salted</i>			
(0 mEq K+/serv)	12 Servings	12 Servings	10 Servings
<i>Low-Protein Bread/Pasta</i>			
(.5 mEq K+/serv)	6 Servings	5 Servings	2 Servings
<i>CHO Supplement</i>	Unlimited	Unlimited	Unlimited

Protein-Controlled Diets

Suggested Meal Plan, 60gm Protein, 38 mEq K+

Breakfast	Lunch	Dinner
240cc Apple Juice and 30cc Polycose	60gm Meat or Substitute	60gm Meat 60gm Meat or Substitute
1 Serving Hot Cereal	1 Serving Vegetable (Group 1)	1 Serving Vegetable (Group 1)
1 Egg or Substitute	2 Serving Fruit (Group 1)	2 Servings Vegetable (Group 2)
1 Slice Bread	2 Slices Low-Protein Bread or 1 Cup Low-Protein Pasta	2 Servings Fruit (Group 1)
3 Margarine	3 Margarine	2 Servings Bread or Starch
3 Jelly	240cc Lemonade and 30cc Polycose	4 Margarine
120cc Milk Beverage		240cc Lemonade and 30cc Polycosev

Protein Restricted Diet (Without Sodium and Potassium Restriction)

Listed below are the average protein contents of foods in the following food groups:

Food Groups	Serving Size	Gm Protein/Serving
Dairy <i>Skim, Lowfat, Chocolate, Buttermilk, or Whole Milk.</i>	1 cup	8 gm
Meat or Substitute <i>Beef, chicken, duck, lamb, liver, pork, turkey, veal, fish, lentils, egg, cheese.</i>	1 oz (cooked) 1/2 cup 1/1 oz.	7 gm
Vegetables <i>Fresh, canned, or frozen without added cream sauce, cheese, or meat.</i>	1/2 cup	2 gm
Fruit & Fruit Juice	1 small, 1/2 cup	.5 gm
Bread & Starch <i>Bread, cereal, pasta, rice.</i>	1 slice, 1/2 cup	3 gm
Low-Protein Bread & Starch	1 slice, 1/2 cup	.5 gm
Fats <i>Butter, margarine, cream, oil, salad dressing not containing cheese.</i>		trace

Protein-Controlled Diets

Beverages		
<i>Lemonade, koolaid, carbonated beverages, coffee, tea (those containing milk will be calculated in dairy group or as designated on the label).</i>		trace
Soup		
<i>Broth-based,</i>	1 cup	3 gm
<i>Cream-based, or lentil.</i>	1 cup	5 gm
Desserts		
<i>Cake, cookies</i>	1 slice, 4 small	2 gm
<i>Jello, pudding, ice cream</i>	1/2 cup	3 gm
<i>Fruit pie</i>	1 slice	7 gm
Miscellaneous		
<i>Fruit ice, popsicle, hard candy, jam, jelly, honey, sugar, syrup, carbohydrate supplements</i>		trace

Suggested Meal Plan

Food Groups	20gm Protein Serving/Day	40gm Protein Serving/Day	60gm Protein Serving/Day
Dairy	1/2	1/2	1/2
Meat or Substitute	1 oz.	3 oz.	5 oz.
Vegetable	2	2	2
Fruit & Fruit Juice	6	6	6
Bread & Starch	0	2	4
Low-Protein Bread or Starch	6	5	2
Fats	unlimited	unlimited	unlimited
Beverages (no milk)	unlimited	unlimited	unlimited
Soup (see guidelines)			
Dessert (see guidelines)			
Miscellaneous	unlimited	unlimited	unlimited

The above pattern can be individualized for the patient based on foods he will/will not consume. See the Guidelines for average protein content of other foods to include such as soup and desserts. Mixed dishes can be calculated into the diet by using the protein content specified in designated reference manuals.

Protein-Controlled Diets

References

1. Giovannetti, S. Nutritional Treatment of Chronic Renal Failure, Noewell: Kluwer Academic Publisher, 1989.
2. Ihie, B.U., Becker, G.H., et al. The Effect of Protein Restriction on the Progression of Renal Insufficiency. *N Eng J Med*, 321(26):1773, 1989.
3. Walker, J.D., Bending, J.J., et al. Restriction of Dietary Protein and Progression of Renal Failure in Diabetic Nephropathy. *Lancet* 2 (8677):1411, 1986.
4. Food and Nutrition Board, National Research Council: Recommended Dietary Allowances, Washington D.C., National Academy of Sciences, (Current Edition).
5. Burton, B.T., Hirschman, S.H. Current Concepts of Nutritional Therapy in Chronic Renal Failure: An Update. *J AM Diet Assoc*, 82(4):359, 1983.
6. Woo, J., Cannon, D. Metabolic Intermediates and Inorganic Ions. Henry, J.B., ed. *Clinical Diagnosis and Management by Laboratory Methods*. W.B. Saunders Co, 1984.
7. Shils, M.E., Young, V.R. *Modern Nutrition in Health and Disease*, 7th Ed. Philadelphia: Lea and Febiger, 1988.
8. Klahr, S. The Modification of Diet in Renal Disease Study. *N Engl J Med*, 320(13):864, 1989.
9. Brown, M.L., ed. *Present Knowledge in Nutrition*, Washington, D.C., International Life Sciences Institute, 1990.
10. Mitch, W.E., Klahr, S. *Nutrition and the Kidney*. Boston: Little Brown and Company, 1988.
11. Mansy, H., Goodship, J.H., et al. Effect of High Protein Diet in Patients with the Nephrotic Syndrome. *Clin Sci*, 77(4):445, 1989.
12. Gentile, M.G., Manna, G.M., et al. Vitamin Nutrition in Patients with Chronic Renal Failure and Dietary Manipulation. *Contrib Nephrol*, 65:43, 1988.
13. Massachusetts General Hospital Department of Dietetics, *Diet Reference Manual*, 2nd Edition, 1984.